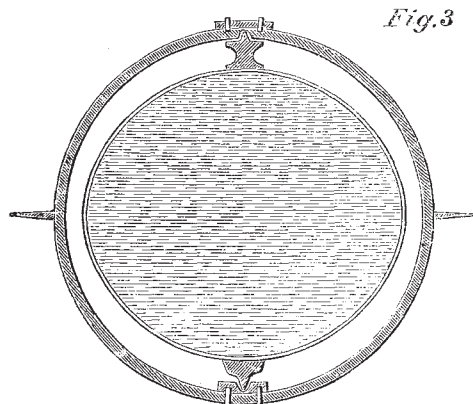
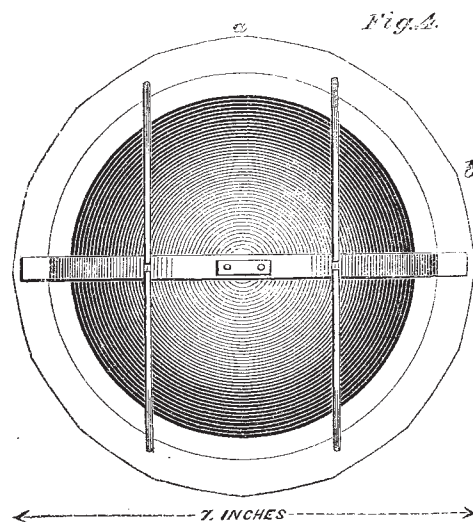


greater than the distance of the corners from the centre. The friction of the fly-wheel would, if the bearing-edge were circular, cause the case to roll along on it like a hoop, and it is to prevent this effect that the curved polygonal form described above and represented in the drawing is given to the bearing-edge.

To spin the solid gyrostat a piece of stout cord about forty feet long and a place where a clear run of about



sixty feet can be obtained are convenient. The gyrostat having been placed with the axis of its fly-wheel vertical, the cord is passed in through an aperture in the case, two-and-a-half times round the bobbin-shaped part of the shaft, and out again at an aperture on the opposite side. Having taken care that the slack cord is placed clear of all obstacles and that it is free from kinks, the operator holds the gyrostat steady so that its case is prevented from turning, while an assistant pulls the cord through by running, at a gradually increasing pace, away from the instrument, while holding the end of the cord in his hand. Sufficient tension is applied to the entering cord to prevent it from slipping round on the shaft. In this way a very great angular



velocity is communicated to the fly-wheel, sufficient, indeed, to keep it spinning for upwards of twenty minutes.

If when the gyrostat has been spun it be set on its bearing edge with the centre of gravity exactly over the bearing point, on a smooth horizontal plane such as a piece of plate-glass lying on a table, it will continue apparently stationary and in stable equilibrium. If while it is in this position a couple round a horizontal axis in the

plane of the fly-wheel be applied to the case, no deflection of this plane from the vertical is produced, but it rotates slowly round a vertical axis. If a heavy blow with the fist be given to the side of the case, it is met by what seems to the senses the resistance of a very stiff elastic body, and, for a few seconds after the blow, the gyrostat is in a state of violent tremor, which, however, subsides rapidly. As the rotational velocity gradually diminishes, the rapidity of the tremors produced by a blow also diminishes. It is very curious to notice the tottering condition, and slow, seemingly palsied, tremulousness of the gyrostat, when the fly-wheel has nearly ceased to spin.

In the liquid gyrostat the fly-wheel is replaced by an oblate spheroid, made of thin sheet copper, and filled with water. The ellipticity of this shell in the instrument exhibited is $\frac{1}{10}$, that is to say, the equatorial diameter exceeds the polar by that fraction of either. It is pivoted on the two ends of its polar axis in bearings fixed in a circular ring of brass surrounding the spheroid. This circle of brass is rigidly connected with the curved polygonal-bearing edge which lies in the equatorial plane of the instrument, thus forming a frame-work for the support of the axis of the spheroidal shell. In Fig. 3 a section is represented through the axis to show the ellipticity, and Fig. 4 gives a view of the gyrostat as seen from a point in the prolongation of the axis. To prevent accident to the shell when the gyrostat falls down at the end of its spin, cage bars are fitted round it in such a way that no plane can touch the shell.

The method of spinning the liquid gyrostat is similar to that described for the solid gyrostat, differing only in the use of a very much longer cord and of a large wheel for the purpose of pulling it. The cord is first wound on a bobbin, free to rotate round a fixed pin. The end of it is then passed two-and-a-half times round the little pulley shown in the annexed sectional drawing, and thence to a point in the circumference of the large wheel to which it is fixed. An assistant then turns the wheel with gradually increasing velocity, while the frame of the gyrostat is firmly held, and the requisite tension applied to the entering cord to prevent it from slipping round the pulley.

WILLIAM THOMSON

REMARKABLE PLANTS

I.—THE COMPASS-PLANT.

"Look at this delicate plant that lifts its head from the meadow,
See how its leaves all point to the north, as true as the magnet;
It is the compass-plant that the finger of God has suspended
Here on its fragile stalk, to direct the traveller's journey
Over the sea-like, pathless, limitless waste of the desert."

LONGFELLOW'S *Evangeline*.

IT has long been known that there grows on the prairie-lands of the south-western part of the United States of America, especially Texas and Oregon, a plant which has the peculiar property of turning its leaves towards the north, and which hence serves as a magnet to the traveller when no other means is available of ascertaining the points of the compass. It is probable, however, from Longfellow's description of it as a "delicate plant" on a "fragile stalk," that he never saw it growing. The Compass-plant is a member of the enormous natural order Compositæ, known to botanists as *Silphium laciniatum*. It is described as a stout perennial plant from three to six feet in height, with ovate, deeply-pinnatifid leaves and large yellow heads of unisexual flowers, the ray-florets strap-shaped and female, the disc-florets tubular and male. It is also known as the pilot-weed, polar-plant, rosin-weed, and turpentine-weed, the two last names being derived from the abundant resin exuded by the stem; and is occasionally to be seen in English gardens.

The "polarity" of the leaves of this singular plant has long been familiar to hunters and other denizens of the prairie, who, "when lost on the prairies in dark nights,

easily get their bearings by feeling the direction of the leaves." But the first occasion on which it was brought under the notice of scientific men appears to have been in communications addressed to the National Institute at Washington in August, 1842, and January, 1843, by General Alvord. The accuracy of his statement having been questioned, the General presented another communication at the second meeting of the American Association for the Advancement of Science, held at Cambridge, Mass., in August, 1849, in which he confirms his own observations by those of other officers, all agreeing in the conclusion that the radical leaves of the plant really present their edges north and south, while their faces are turned east and west, the leaves on the developed stems of the flowering plant, however, taking rather an intermediate position between their normal or symmetrical arrangement and their peculiar meridional position. For the following particulars respecting the phenomena exhibited by the compass-plant we are indebted mainly to a paper by Mr. W. F. Whitney, read before the Harvard Natural History Society and printed in the *American*



The Compass-plant (*Silphium laciniatum*).

Naturalist for March, 1871, and to some subsequent notes by Prof. Asa Gray and Mr. Thos. Meehan.

The cause of the ordinary position of the leaves of most plants, one surface being directed towards the sky and the other towards the earth, is generally believed to be a difference in the sensitiveness to light of the two surfaces, the epidermal tissue of the upper being generally denser and less pervious to light than that of the under surface. It is possible also that something may be due to the fact that the under surface of the leaf is almost always more copiously furnished with stomates or "breathing-pores," as they are often inaccurately termed, minute orifices, which serve to promote a diffusion of gases between the external air and the intercellular cavities within the tissue, and especially an abundant exhalation of aqueous vapour. A microscopical examination of the leaves of the compass-plant shows that the structure of the epidermal tissue of the two surfaces is similar, and also that the number of stomates in each corresponds, affording in this respect a contrast to other allied species of the genus *Silphium*, which do not exhibit the phenomenon of polarity, and in whose leaves the

stomates were found to be from two to three times as numerous on the under as on the upper surface. If, therefore, the object to be gained is an equal sensitiveness to light, it is obvious that the two surfaces will receive an equal mean amount of light during the twenty-four hours, if they face the east and the west, rather than if they face the north and the south, or the earth and the sky. An attempt has also been made to explain the phenomenon of polarity by currents of electricity induced by the peculiar chemical composition of the substances secreted by the stem and the leaves, but not with much success.

In a recent communication to the Academy of Natural Sciences at Philadelphia, Mr. Meehan says that those who affirm that the leaves are directed to the north, and those who say that there is no such tendency, are both right. He watched a plant in his own garden, and observed the unmistakable northern tendency in the leaves when they first came up, and until they were large and heavy, when winds and rain bore them in different directions, and they evidently had not the power of regaining the points lost. It would appear, therefore, to depend on the season when the observation is made whether the leaves are seen to bear northwards or not.

The same observer records also the following facts with regard to the flowers of the compass-plant. The expansion of the ray-florets in August was observed to begin at daybreak, 4 A.M.; forty minutes afterwards the florets of the disc began to open, and the whole of the corollas were expanded in about three-quarters of an hour, after which there was no further growth in the corollas. The stamens and pistils were gradually protruded beyond the corolla, and the lengthening of the stamens ceased at 6 A.M. After 6.20 no further growth was noticed in the flowers. Later on they were visited by insects, causing the detachment of the florets of the disc, and the scattering of the pollen on to the ray-florets, which were thus fertilised. There appear, in fact, to be three phases of growth, with a slight rest between each, the pistil taking the most time, then the stamens, and the corolla the least; but the whole growth of the day is included within two hours.

The geographical range of the plant is stated to be from Texas on the south to Iowa on the north, and from Southern Michigan on the east to 300 or 400 miles west of Missouri and Arkansas. Its chief habitat is rich prairie land. Our illustration is taken partly from the plate in Jacquin's "Eclogæ," the only good drawing of the plant published, assisted by comparison with dried specimens in the Kew Herbarium. A. W. B.

EXPERIMENTS WITH THE RADIOMETER¹

II.

HAVING ascertained that the action of the radiometer was due to the internal movement of the molecules of the residual gas, it became important to obtain as much information as possible respecting the physical properties of this residue.

In the apparatus constructed for this purpose a vertical plate is suspended by a glass fibre, which it twists in opposite directions alternately, instead of continuously rotating in one direction, as in the ordinary radiometer. Attached to this apparatus there is:—*a*, a Sprengel pump; *b*, an arrangement for producing a chemical vacuum; *c*, a lamp with scale, on which to observe the luminous index reflected from a mirror; *d*, a standard candle at a fixed distance; and *e*, a small vacuum tube, with the internal ends of the platinum wires close together. I can therefore take observations of—

1. The logarithmic decrement of the arc of oscillation when under no influence of radiation.

¹ Continued from p. 227.